Transport Decarbonisation Index (TDI) Methodology Report

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Abstract	

This report outlines the complete methodological framework for the Transport Decarbonisation Index (TDI), covering all essential elements for assessing a country, including indicators, normalisation, weighting and aggregation approaches. It details the calculation methods at every level of the TDI, such as indicators, dimensions and the overall composite score. Following the assessment, the TDI supports informed policy making by offering illustrative, non-prescriptive policy guidance. The TDI will be made accessible through a spreadsheet toolkit.

The TDI methodology report provides a comprehensive explanation for specific types of end users, namely researchers and practitioners, offering detailed background information on how the TDI functions. It includes calculation methods, a final list of indicators and high-level strategies to address data gaps.

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Abbreviations/Acronyms

A-S-I-F	Activity-structure-intensity-factor of emissions
ATO	Asian Transport Outlook
CO_2	Carbon dioxide
EDGAR	Emissions Database for Global Atmospheric Research
GDP	Gross domestic product
HVT	High-volume transport
JRC	Joint Research Centre of the European Commission
LMICs	Low- and middle-income countries
MJ	Megajoule
NDC	Nationally Determined Contribution
PCA	Principal component analysis
TDI	Transport Decarbonisation Index
ZEV	Zero-emission vehicle

Executive Summary

This report presents the methodological framework for the Transport Decarbonisation Index (TDI). The TDI aims to assist low- and middle-income countries (LMICS) in Sub-Saharan Africa and South Asia in assessing their readiness to reduce greenhouse gas emissions in surface transport. This diagnostic toolkit offers data-driven insights for targeted policy interventions on transport sustainability and decarbonisation.

The TDI is built upon a four-phase methodological approach: 1. setting objectives, 2. constructing the composite indicator, 3. evaluating its performance, and 4. applying the results. These phases ensure the index remains dynamic, allowing iterative improvements and stakeholder feedback. Key principles guiding the TDI's development include transparency, robustness, credibility, collaboration, and relevance to local contexts. This methodology focuses on the second phase and provides in detail all necessary steps for the construction of the composite indicator.

The methodology covers the selection criteria, normalisation, weighting, aggregation of the indicators and the provision of non-prescriptive policy guidance. A broad range of indicators across eight dimensions is featured in the TDI. The dimensions are passenger mobility, light-duty vehicles, freight systems, finance, economics, governance, energy, and carbon intensity. These dimensions reflect core elements of surface transport sustainability and decarbonisation.

The TDI scoring results are linked to illustrative, non-prescriptive advice on policy actions with the intention to support evidence-based and informed policy decision-making. The policy guidance outlines how a country can improve and decarbonise its transport system. The methodology report introduces a list of policy actions, based on the scores for the dimensions, related policy actions will be highlighted.

In addition to the methodology and policy guide, the TDI will feature a spreadsheet toolkit that should enable policymakers and practitioners to apply the TDI. The toolkit facilitates country assessments through an input masks and an overview of data sources. The report outlines strategies for overcoming common data gaps through the use of proxy indicators, collaborative data collection and leveraging regional databases. Through its comprehensive framework and practical tools, the TDI aims to empower LMICs to make informed decisions and accelerate the transition to sustainable transport systems.

1 Introduction

1.1 About the Transport Decarbonisation Index (TDI)

The HVT057: Surface Transport Decarbonisation Index (TDI) project is producing a diagnostic toolkit to assess progress and barriers and enable evidence-based, time-sensitive and targeted decisions on emission reductions towards surface transport decarbonisation in low- and middle-income countries (LMICs) in Sub-Saharan Africa and South Asia.

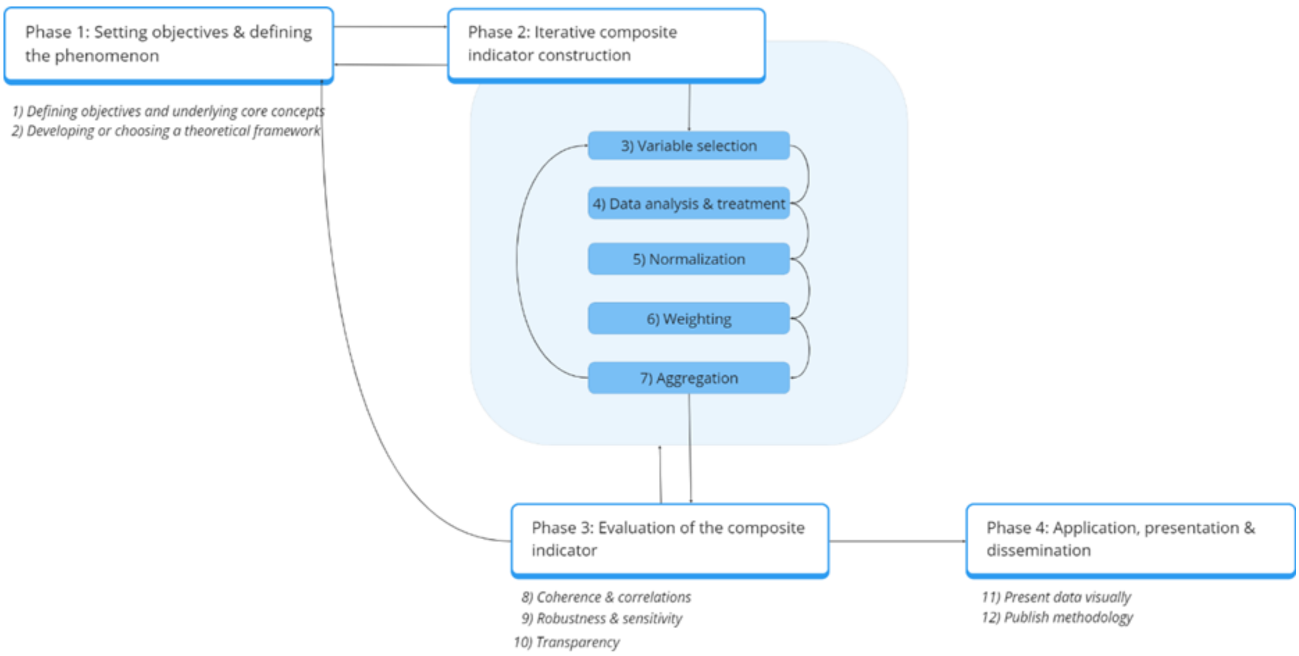
This report is intended to provide a complete methodology for the TDI. It covers all steps in the development of the full TDI methodology, including a complete list of indicators. The methodology outlines in detail how the calculations work and how to conduct each of the steps towards the benchmarking of a country. The main purpose is to allow anyone to gain a complete understanding of how the TDI was developed and which steps a user has to conduct to benchmark transport in a country of their choice. This report does not include numeric results, except for some examples. Numeric results and scores will be provided in a later report.

1.2 Guiding principles

As outlined in the State of Knowledge Report, the development of the Surface TDI follows a structured four-phase approach (see Figure 1). These phases are: 1) setting objectives and defining the phenomenon, 2) iterative composite indicator construction of the TDI, 3) evaluation of the composite indicator, and 4) application, presentation, and dissemination of the TDI results and supporting documents.

In line with the methodology for developing indices, the concept presented in this report is dynamic, allowing for iterative adjustments and feedback from relevant stakeholders and providing a basis for further discussion (see Phase 2 of Figure 1).

Figure 1: Four-phase methodology of Surface TDI development

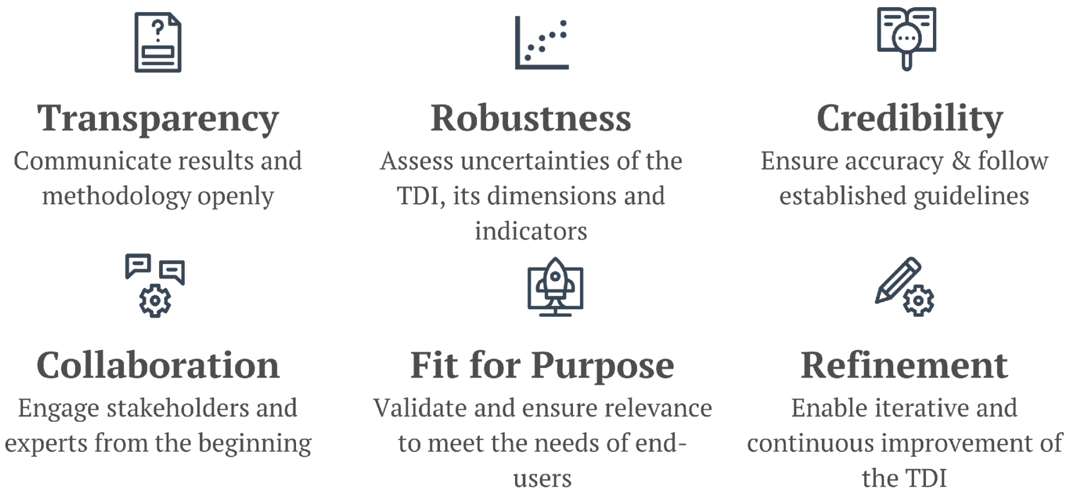


Based on the literature review conducted for the State of Knowledge Report, six overall criteria have been identified for the development of the TDI (see Figure 2).

- **Transparency:** There is a need for transparency in both the construction of the TDI and the dissemination of its methodology and outcomes.

- **Robustness:** A rigorous approach must be followed in the construction and validation of the TDI, using proven statistical techniques and assessing uncertainties to ensure the robustness of the TDI, its dimensions and its indicators.
- **Credibility:** The developers of the TDI must ensure accuracy and follow established guidelines to ensure the credibility of the index.
- **Collaboration:** Identifying the primary end users and audience of the TDI is crucial, and collaboration with relevant stakeholders and experts should be ensured throughout the development, validation and application phases.
- **Fit for Purpose:** The TDI should be actionable and fit for purpose. This means ensuring that it captures the aspects and dimensions relevant to the target audience, and validating the viability, relevance and usefulness of the results and means for communicating and disseminating the outcomes.
- **Refinement:** The TDI should allow for iterative continuous improvement during the four development phases. This includes the flexibility of re-evaluating and adjusting selected dimensions, indicators, methods and data sources to improve the quality and robustness of the TDI when necessary.

Figure 2: Guiding principles and quality criteria for the development of the TDI



The methodology has been developed using an iterative approach that is based on a process covering a comprehensive literature review through the State of Knowledge Report; initial conceptualisations; an initial methodology and data source report and consultations; a multi-stakeholder practitioner workshop; and a stakeholder review workshop.

The State of Knowledge Report and inputs from the multi-stakeholder practitioner workshop have provided valuable guidance on the principles for the TDI, such as transparency, rigour, and relevance, ensuring that the index is both scientifically robust and practically useful. The workshop, in particular, has served as a crucible for refining the TDI's scope, sharpening its focus on the most impactful areas of surface transport decarbonisation, and identifying methodological approaches that balance comprehensiveness with feasibility.

The piloting of the TDI, conducted in two phases, provides key insights for the finalisation of the methodology. The results of the piloting are covered in in the TDI Benchmarking Report. In the TDI Benchmarking Report, country-specific information, results of the TDI analysis and key issues surrounding sustainable, low-carbon transport will be highlighted. Although this TDI Methodology Report benefits from the initial benchmarking and pilot phase, it focuses solely on outlining the methodological steps for applying the TDI, without providing any country-specific examples.

All project outputs can be found on the official project website.

1.3 Structure of the TDI Methodology Report

This TDI Methodology Report provides a complete picture of the TDI's approach, concept and elements. The report is structured along the following sections:

Section 1 introduces the report by explaining all necessary information about the project, the guiding principles and the structure of the report.

Section 2 describes the framework of the TDI by listing the objectives and key aspects of the TDI and the conceptual framework that shaped it. This section provides the necessary background information for the basic understanding behind the TDI.

Section 3 compiles the main methodology with all elements of the TDI. The indicator selection and structure, normalisation process, weighting and aggregation are featured in detail. The connection to policy guidance is laid out in this section.

Section 4 shows how the TDI is being applied and how common issues around data gaps and narrative can be handled. It describes the TDI spreadsheet toolkit, which features a step-by-step guide for TDI application. Strategies to overcome data gaps are shown, and ways to communicate the results of the TDI are explained.

Section 5 summarises the key points of the TDI Methodology Report.

2 Framework of the TDI

2.1 Objectives and key aspects

The objectives of the Transport Decarbonisation Index (TDI), as stated by the HVT Applied Research programme, are:

- To assist LMICs in Africa and South Asia in reducing greenhouse gas emissions in surface transport by providing a diagnostic toolkit;
- To assess a country's condition (such as energy and infrastructure readiness, transport-related assets, scale and nature of key investments) with respect to the achievement of net zero emissions by 2050;
- To enable comparisons with other nations and tracking of long-term progress;
- To better understand which measures are most effective for countries' specific circumstances, taking into account factors such as development status and transport system characteristics;
- To not only diagnose decarbonisation, but also measure progress and indicate if more stringent measures are required.

To achieve these objectives, the index must relate to countries' current policy priorities (e.g. overall and transport-specific GHG/CO_2 emission reduction targets; safe, affordable, accessible, and sustainable transport, fiscal and regulatory measures) and be coupled with their actual surface transport situation at the time of measurement. Table 1 outlines key aspects that have been selected to describe the scope of and steer the development of the Surface TDI.

Table 1: Key aspects of the TDI

Aspect	Description
End-user group	• Priority 1: Policy makers, transport community and practitioners. • Priority 2: Academia, finance and private sector.
Time orientation	• Current status and historical development.
Coverage	• Emissions and transport system status, decarbonisation action and readiness. • National level.
Stage in decision making	• Assisting LMICs to gain a better insight into which measures may be most effective given their circumstances and to enable measurement and verification of the decarbonisation of surface transport. • Supporting the identification of barriers and enablers for the transition to net zero emissions in surface transport and shedding light on financing needs and opportunities. • It can be used as a tool to create transparency on the current status of decarbonisation efforts to support **agenda setting**, **policy formulation** and the alignment of **policy decisions**.
Index applications	• Describing and reviewing a country's transport performance with a view to achieving net zero emissions by 2050, comparing it with other countries and tracking progress over the years. • To attain the envisaged results of the TDI, it is essential that the index is widely available and user-friendly. Suitable materials to effectively communicate the TDI methodology, results and data to the TDI end-user groups will be developed based on the needs of the respective target groups. • The TDI spreadsheet tool and methodology will be provided openly to enable own analysis.

Synergies and partnerships	• The TDI is intended as a collaborative initiative that aims to build and enhance partnerships with existing platforms and efforts, rather than as an isolated endeavour. During the second and third phase of index development, efforts have been made to identify and leverage synergies with current initiatives. This aims to foster collaboration to enrich the TDI development process and promote mutual benefit for all parties. • Using the Asian Transport Outlook (ATO) database as a first step provides a pragmatic approach to data collection for the TDI, particularly for South Asia. The ATO database provides a structured framework that not only helps in collecting the required data, but also serves as a model for structuring similar data collection frameworks in African countries. We envision that efforts similar to the ATO will be beneficial for the African region, where data availability is challenging. In the medium term, this approach could inspire the creation of a similar database for the African region. • In addition, a partnership with existing indices such as the Sustainable Urban Transport Index (SUTI) and the Sustainable Cities Index offers the opportunity to leverage synergies, and mutual benefits will be explored. By incorporating insights from a wider range of cities worldwide, the TDI could improve its analysis, for example by contributing to a national urban mobility score. For instance, these indices could benefit from a collaboration with the TDI development team and the Urban Living Lab Center to foster partnerships with new cities and increase coverage, while the TDI would greatly benefit from existing data. • Other examples for initiating partnerships to overcome data gaps and challenges include OpenStreetMap, Sustainable Mobility for All (SUM4All) with a focus on SDG tracking, and the Transport Data Commons Initiative (TDCI), that will soon undertake data collection in Asia and Africa. • Finally, the data collected and generated by the TDI hold potential for future initiatives, as these data enable the modelling of development projections and trajectories.

Concepts towards sustainable transport

Based on the consultations and the review of the state of knowledge, the TDI is designed to cover a range of relevant topics (see Figure 3). These include considerations related to the A-S-I-F (activity-structure-intensity-factor of emissions) framework (explained below), such as transport modes and technologies, energy system readiness, infrastructure quality, and emission pathways and targets. The TDI also aims to capture readiness and action aspects related to rural accessibility and access to low carbon transport modes, the financial and policy landscape supporting decarbonisation efforts, and user perspectives.

Moreover, the context of each country should be taken into account, for example with regard to the level of development, the availability of natural resources (e.g. oil, minerals), the presence of manufacturing capacity (e.g. to process natural resources, and/or export them, or to produce transport vehicles and build transport infrastructure), specific geographical characteristics (e.g. access to the coast vs. land-locked nature) and other advantages and disadvantages. The reason for this lies in the implications that these features can have regarding the development of transport and energy-related investments, the fiscal treatment of different resources and therefore also the carbon intensity of transport and energy systems.

Figure 3: Themes to be covered in the Surface TDI

The A-S-I-F framework has been selected as a reference for identifying relevant determinants of greenhouse gas emissions (Schipper, Cordeiro and Ng 2007). Hence, the TDI concept explores the viability of integrating indicators related to the total passenger and freight transport activity, the structure of transport modes, modal energy intensity and the carbon content of fuels of target countries.

The analysis of keyword co-occurrences and frequencies conducted in the State of Knowledge Report has shed light on thematically dominant areas in academic research focusing on indices and sustainable surface transport. In addition to terms such as emissions, energy consumption, efficiency, and growth, other concepts such as urban mobility, accessibility, transit and walkability have been identified. Furthermore, members of the TDI Project Advisory Group have emphasised that decisions in the transport sector extend beyond decarbonisation. Linking the TDI to wider benefits such as accessibility, economic development, air quality and road safety is important – despite limitations in terms of data availability, especially for datasets with consistent methodologies and broad country coverage, as they are crucial for cross-country assessments – to enable a holistic and comprehensive view of transport progress.

2.2 Developing a conceptual framework for the TDI

Based on the substance and intention defined above, core components and indicators for the index based on existing best practices and development pathways have been developed. The TDI is structured around eight main dimensions:

- Passenger transport/mobility system
- Light-duty vehicles
- Freight system and vehicles
- Emissions
- Finance and economics
- Governance
- Energy
- Context

The dimensions operationalise the themes shown in Figure 3. For each dimension, indicators have been proposed that would enable annual tracking of progress within and across countries.

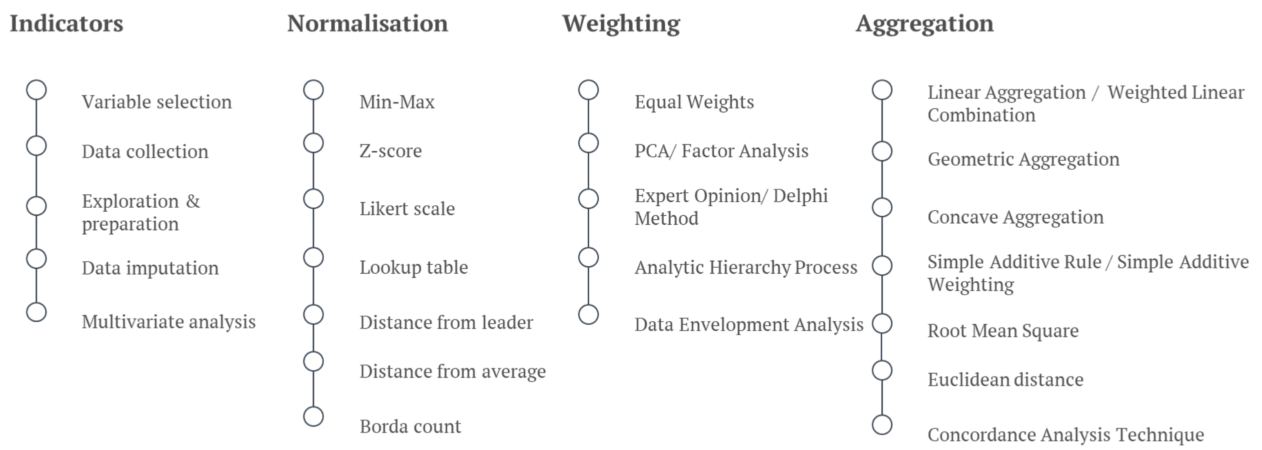
3 Elements of the TDI

The following section is structured by the elements of any major composite indicator system (see Figure 4):

1. Indicators
2. Normalisation
3. Weighting
4. Aggregation

These elements are supported by a fifth point about linking the index to informed decision making and providing policy guidance. This is aligned to the project's initial direction as well as feedback received from consultations.

Figure 4: Methods for index construction



The State of Knowledge Report identified several potential methods for the construction of the TDI. A key for a successful index construction is to undertake several iterative explorations in subsequent phases.

The conceptual framework outlined in this report will form the basis for selecting suitable indicators and assessing their availability and relevance for the TDI. The multi-stakeholder practitioner workshop and the stakeholder review workshop provided valuable insights for the TDI, such as the interest of experts in using open data.

To ensure the robustness, credibility and continuous improvement of the TDI, various methods of normalisation, weighting and aggregation were tested. Figure 4 provides an overview of possible methods to be used and evaluated during the benchmarking of the first pilot countries. Throughout this process, the adjustment of the methods used in the final TDI is possible and in line with existing guidelines such as those of the European Commission's Joint Research Centre (JRC), which are well recognised and common guidelines for composite indicators.

3.1 Variable selection and preparation

Based on the composite indicator concept developed above (Phase 1), Phase 2 begins with the identification and selection of suitable indicators to capture what the index should encompass. The selection of indicators is based on criteria such as availability and sufficient coverage to avoid significant data gaps, interpretability for user understanding, and relevance to capture the key aspects relevant to measure progress towards net zero surface transport. Important criteria are robustness, timeliness, availability, and comparability, while also considering practicability for the target regions (South Asia and Sub-Saharan Africa) (see Figure 5).

Figure 5: Criteria of variable selection

Addressing missing data within the dataset is a critical step for developing a robust and reliable TDI. Using the forward and backward fill method is a simple approach to replace missing values with the latest available data. Alternative and more advanced strategies for dealing with missing values, as proposed by Nardo et al. (2008), include explicit and implicit single imputation methods, such as unconditional mean imputation, regression imputation, expectation maximisation imputation and multiple imputation.

These more advanced methods would be worth adopting if the initial data were known to be of high quality. However, in the case of certain key indicators – for instance, car ownership or passenger activity (passenger-kilometres) by mode – definitional differences across countries, uncertainties inherent in statistical reporting and estimation methods, and other uncertainties make it more important to "sense-check" the data based on reasonable relationships across and among variables, rather than to focus on sophisticated interpolation techniques for missing data.

Taking the example of passenger vehicle ownership, based on previous experience, the authors have determined that definitional and reporting differences across countries mean that in-use car fleets reported by various countries are not necessarily internally consistent, nor globally harmonised. In North America, the definition of "light trucks", most of which are purchased by individuals and used for personal mobility, nevertheless leads to reporting of these vehicles as a separate category from "cars". In many LMICs (such as Indonesia), vehicle fleet numbers are in fact cumulative vehicle registrations, and there is no systematic reporting of vehicles that have been scrapped and are no longer operating.

Data availability and sufficient coverage must be guaranteed to avoid significant data gaps. The Data Source Report supports the TDI application by assessing and providing an overview of data sources.

For instance, when selecting the final set of indicators, Saisana et al. (2019) advise ensuring at least 65% data availability for at least 65% of the selected indicators, for inclusion of a country in the TDI. A higher percentage is of course better. Similarly, an indicator should be included in the TDI only if data are available in at least 65% of the countries analysed.

We take a similar approach, balancing the need for minimal coverage with pragmatism regarding data availability. We prioritise indicators drawn from international databases with coverage across at least 100 countries, with annual updates, and with recent coverage (ideally including data at least from the past five years, and ideally through the past year or two), across the majority of LMICs.

Restricting our efforts to these parameters ensures that countries using the TDI are able to:

- identify and ideally address key data in national data collection and reporting;
- track progress over time; and
- compare performance across similar countries (e.g. neighbouring countries or countries at a similar level of economic development).

There is, however, a major trade-off that comes from restricting data collection, validation and scoring efforts to international databases. This is the risk of not considering highly relevant and valid indicators that are not systematically reported and collected globally, but that are, in many instances, collected and available at a national level. An example is ridership statistics (e.g. average occupancy rates) on public transport. Other examples cover transport costs, and therefore also equity-related aspects.

Moving forward, we aim to highlight the key parameters that are absent from or lacking sufficient coverage in international data sources. The dual aims of maintaining this list are: 1) to highlight parameters that international institutions[1] could begin to compile and report, and 2) to inform policy makers and transport specialists working within countries about key indicators for tracking the performance of their surface transport systems, highlighting global best practices for data collection and decision making.

The criteria for selecting indicators can be applied similarly to selecting the right data sources to ensure that the data used in the TDI are credible, accessible and reliable. This framework for the evaluation and selection of the final set of indicators and data sources is based on the above criteria and guided by references such as Joumard and Gudmundsson (2010).

Taking into account all the principles and goals listed above, the research team investigated a wide range of potential sources for large-scale databases and created a preliminary database that includes the indicators listed in Table 2. This is an evolving list, and not all of these indicators qualify for the availability criteria across a large number of countries and very recent years. However, they all come from data sets that are authoritative and do include many countries. This list has also been vetted based on the piloting work on the TDI.

Table 2 shows the indicators structured into nine distinct dimensions. The first dimension (demographic indicators) captures data important for normalisation (i.e. calculating relative scores on a per capita or per GDP basis). The other eight dimensions are all considered important to measure transport sustainability and decarbonisation.

Table 2: Structure of TDI indicators

0. Demographic indicators

Specific indicator	Metrics and units	Basis for inclusion
0.a National population	Number of people	Allows all other variables to be normalised per capita
0.b Urban population	Number of people	
0.c Gross domestic product or average income	Country currency, and converted to current international dollars based on purchasing power parity	Allows all variables to be normalised per unit of gross domestic product
0.d Income group or age-based population and gross domestic product	Values per quartile or quintile	Useful if any indicator data are also available broken out this way; otherwise of minor value

[1] These include financial institutions such as the World Bank and International Monetary Fund; inter-governmental agencies like the Organisation for Economic Co-operation and Development (OECD) and its sister agencies (the International Energy Agency and the International Transport Forum); UN agencies, and other organisations tracking climate and energy data (e.g. Ember, Climate Action Tracker, etc.) and transport data (e.g. Institute for Transportation and Development Policy (ITDP), SLOCAT Partnership for Sustainable, Low Carbon Transport, etc.).

1. Passenger transport / mobility system indicators

Specific indicator	Metrics and units	Basis for inclusion as a priority indicator
1.a Trip or person kilometres travelled share of passenger transport / non-motorised transport	Typically as a share of 100% of trips or kilometres, for urban travel it may only include large urban areas, based on data availability	Strongly indicative of the use of the most sustainable (less energy intensive, less CO_2 intensive) modes. Higher values for transit, cycling, walking would typically be given a higher sustainability score
1.b Public transport (bus, rail) system extent	Total kilometres of bus rapid transit, metro, tram / light rail system operating (could be combined or counted separately); can also be tracked per capita	Key measure of sustainability mobility and access, especially for lower-income groups
1.c Percent near frequent public transport	Percentage of residents who live within 500 metres of public transport with minimum performance criteria	Access to minimum level of passenger transport is a key sustainability indicator
1.d Percentage near protected bikeways	Percentage of residents who live within 500 metres of a protected bikeway, in major cities	Promotion of safe cycling is a key sustainable mobility strategy
1.e Walkability score	Based on walkability indices	Measures ease of moving around a city as a pedestrian
1.f Transit ridership	Average daily ridership; can be set per capita and/or per system length to measure intensity of utilisation	Ridership reflects both system availability and performance
1.g Infrastructure investment	Expenditure by all parties on specific things like transit system construction, walking/cycling infrastructure, and vehicle charging systems; can be tracked separately; can be shown as units per vehicle or per capita	Expenditures on sustainable infrastructure is a key metric of a country's commitment to moving in this direction
1.h Rural transport access	Road density, frequency of transit services to villages, availability of two-wheeled motor vehicles	Measures mobility of rural, often poor

2. Light-duty vehicle indicators

Specific indicator	Metrics and units	Basis for inclusion as a priority indicator
2.a Light-duty vehicle (car, SUV) ownership rates	Total private LDV stock divided by population, usually normalised to vehicles per 1,000 people	Higher ownership is indicative of wealth and does provide mobility, but very high rates can be considered less sustainable
2.b Light-duty vehicle sales	Annual sales of private (light-duty) vehicles per capita	Like ownership, sales are indicative of wealth and indicate some level of mobility, but also suggests lower sustainability than if other modes are growing
2.c Vehicle CO_2	Average CO_2 per kilometre across vehicle sales or stock	CO_2 per kilometre is a central measure of total CO_2

2.d Age of fleet	Average age of fleet or stock (synonyms)	Older fleets are typically less safe, with higher pollutant emissions
2.e Average age of vehicles sold or imported	Average age of vehicles sold and second-hand vehicles imported in year	Older average age suggests higher emissions, possibly less safe vehicles
2.f Light-duty zero-emission vehicle sales / stocks, shares	Sales of battery electric, plug-in hybrid electric, and fuel cell vehicles, or share of new vehicles	Higher sales of zero-emission vehicles suggests low pollutant, fossil fuel, and CO_2 emissions, although this depends on a country's grid score
2.g Two/three-wheeler zero-emission vehicle sales / stocks, shares	Sales of battery electric, plug-in hybrid electric, and fuel cell vehicles, or share of new vehicles	Higher sales of zero-emission vehicles suggests low pollutant, fossil fuel, and CO_2 emissions, although this depends on a country's grid score
2.h Bus zero-emission vehicle sales / stocks, shares	Sales of battery electric, plug-in hybrid electric, and fuel cell vehicles, or share of new vehicles	Higher sales of zero-emission vehicles suggests low pollutant, fossil fuel, and CO_2 emissions, although this depends on a country's grid score

3. Freight system and vehicles

Specific indicator	Metrics and units	Basis for inclusion as a priority indicator
3.a Truck versus rail / water share	Tonne-kilometres of freight movement by mode; share of non-truck to truck	Non-truck (e.g. rail, water) modes are typically much more efficient than truck
3.b Truck emissions ratings	E.g. Euro emissions rating system average for trucks sold or in service	Indicative of truck emissions and impacts on urban air quality
3.c Zero-emission vehicle truck sales / stocks, shares	Sales of battery electric, plug-in hybrid electric, and fuel cell vehicles, or share of new vehicles	Higher sales of zero-emission vehicles suggests low pollutant, fossil fuel, and CO_2 emissions, although this depends on a country's grid score
3.d Truck in-use emissions per tonne-kilometre	Emissions per vehicle-kilometre or tonne-kilometre	If actual in-use data are available, this provides a real-world estimate of truck emissions
3.e Infrastructure investment	Expenditures on freight systems, especially rail, water; multi-modal; electricity charging infrastructure	Measures intensity of effort to move toward multi-modal and zero-emission vehicle transport systems

4. Emission indicators

Specific indicator	Metrics and units	Basis for inclusion as a priority indicator
4.a Total transport CO_2	Tonnes/year, total and per capita	Tracks overall CO_2 and relative contributions
4.b Transport CO_2 by mode	Tonnes/year, by mode and total	Tracks relative contributions by mode

5. Finance and economics indicators

Specific indicator	Metrics and units	Basis for inclusion as a priority indicator
5.a Clean transport (or passenger transport / non-motorised transport) investment	Total investment in clean fuels, vehicles and infrastructure	Measures strength of effort to transition
5.b Fossil fuel subsidies	Total value of fossil fuel subsidies	Runs directly counter to sustainability
5.c Clean transport fiscal policies / incentives	E.g. the number and strength of policies; can be complex to measure	Indicative of commitment to sustainability
5.d Availability of low-cost climate finance	Annual climate finance flows of climate-related official development assistance	Indicates country's ability to raise capital for climate / sustainability
5.e Transport (or fossil transport) household expenditures	Expenditures per person or family, as a share of income if possible	Cost of mobility; relative expenditures on sustainable mobility

6. Governance indicators

Specific indicator	Metrics and units	Basis for inclusion as a priority indicator
6.a Climate targets	Existence and timing (year to 0)	Measures overall commitment
6.b Transport climate targets	Existence and timing (year to 0)	Commitment specific to transport
6.c Vehicle regulatory policy strength, including EV adoption policy	Typically an index; can be constructed; should reflect key vehicle and system sustainability regulations	Measures policy commitment and effectiveness towards sustainability
6.d Clean fuel regulatory policy strength	Fuel specifications and requirements, tax policy	Measures policy commitment and effectiveness towards clean fuels

7. Energy indicators

Specific indicator	Metrics and units	Basis for inclusion as a priority indicator
7.a Renewable / clean energy overall share	Energy shares in country, energy basis; separates renewable from fossil fuel use	Measures actual renewable and clean energy content
7.b Renewable / clean energy share in transport	Fuel shares of transport on energy basis; separates renewable from fossil fuel use	Measures actual renewable and clean energy content in transport sector
7.c Carbon intensity of electricity system	Carbon intensity in grams of CO_2 per kilowatt-hour generated	Measures average carbon intensity of all vehicles using electricity or fuels derived from electricity
7.d Carbon intensity of liquid fuel system (or biofuels or non-fossil share)	Carbon intensity in grams of CO_2 per joule of provided energy	Measures carbon intensity of liquid fuels, which can be reduced via use of biofuels or e-fuels
7.e Road transport fuel prices / taxes	Average price for a fuel mix, with or without taxes / subsidies; could also be the ratio of clean versus non-clean fuel prices	Measures the cost of mobility and possibly the relative cost of clean fuel mobility (fuel aspects anyway); could also take into account vehicle efficiency, in a more complex indicator construction

7.f Crude oil / oil products import dependence	Percent of oil or transport fuel that is imported	Measures vulnerability to import disruption; could also be constructed as the percentage of total energy that is imported

8. Context indicators

Specific indicator	Metrics and units	Basis for inclusion as a priority indicator
8.a Awareness / support for climate policies / investments	Percentage of public shown to be aware of or supporting climate policies	Indicates public support
8.b Road infrastructure (paved / unpaved)	Percentage of roads paved, also roadway per capita	Indicates basic mobility situation
8.c Road safety (deaths)	Deaths or deaths and injuries per capita	Measures safety of system, commitment to sustainability
8.d Specific country challenges to sustainable mobility (landlocked, mountainous, weather)	Some type of vulnerability rating (see suggestions)	Measures resilience and difficulty to achieve sustainability

3.2 Denomination, scoring and normalisation

Following data preparation, the indicators will be normalised to make them usable for aggregation. The first step is to make the indicators comparable across countries, or "denominated", by dividing extensive variables by the total or urban population, the gross domestic product (GDP) or GDP per capita (as a proxy for the level of economic development).

The next step is to "score" the variables – placing them on a continuous scale (e.g. from 0 to 1) or binning them into discrete values based on their distribution or for variables that are inherently ordinal (such as fuel economy standards), rather than continuous. Scoring ensures that indicators that originally have different units of measurement, distributions, and/or variances, as well as different measurement scales, are comparable.

An example is that total kilometres of transport system in a country, which could range from 0 to 10,000 or more, is difficult to compare to an emissions regulation, such as the Euro system, which would typically fall in a range of Euro 3 to 6 (and for which available data is binned into one of four classes: no policy, Below Euro 3, Euro 3, and Euro 4 and above).

The currently adopted denomination methods for the indicators selected and summarised in Table 2 is shown in Table 3. Table 3 also shows, in the last column, the currently adopted scoring methods. A dash indicates that no denomination has been performed, and approaches in parentheses are potential approaches for denomination that have not yet been adopted but could be explored (see later discussion).

Table 3: Normalisation and scoring of indicators

Dimension	Indicator	Denomination (potential alternative approach)	Scoring
1. Passenger transport / mobility system	Public transport (bus, rail) system extent	per capita (based only on urban population)	0-5 (bins) *
	Percent near frequent public transport	per capita (urban population)	0-5 (bins) *
	Percentage near protected bikeways		0-5 (bins) *

Dimension	Indicator	Denomination (potential alternative approach)	Scoring
	Walkability score	–	0-5 (bins) *
	Rural transport access index (RAI)	–	0-1
	Infrastructure investment	per capita (per capita / GDP)	0-1
	National modal shares (passenger-kilometres) road / rail	–	0-1
	Transit ridership	–	0-5 (bins) *
2. Light-duty vehicles	Passenger vehicle ownership rates	per capita (per capita / GDP per capita)	0-1
	Passenger vehicle size (sales)	per capita	0-1
	Passenger vehicle CO_2	– (GDP per capita)	0-1
	Light-duty zero-emission vehicle sales / stock (shares)	– (GDP per capita)	% (0-1)
	Two/three-wheeler zero-emission vehicle sales / stock (shares)	– (GDP per capita)	% (0-1)
	Bus zero-emission vehicle sales / stock (shares)	– (GDP per capita)	% (0-1)
	Age of fleet	– (GDP per capita)	0-1
	Average age of vehicles sold or imported	– (GDP per capita)	0-1
3. Freight system and vehicles	National modal shares (tonne-kilometres) road / rail	– (GDP per capita)	0-1
	Truck emissions ratings	– (GDP per capita)	1-4 (bins) (ordinal variable)
	Zero-emission vehicle truck sales / stock share	– (GDP per capita)	% (0-1)
	Infrastructure investment	per capita	0-5 (bins) *
	Truck in-use emissions per tonne-kilometre	per capita	0-1
4. Emissions	Total transport CO_2	per capita (per capita / GDP per capita)	1-5 (bins) *
	Transport CO_2 by mode	–	0-1
5. Finance and economics	Clean transport fiscal policies / incentives	– (GDP per capita)	1-5 (bins) *
	Fossil fuel subsidies	per capita	1-5 (bins) *
	Climate-related official development assistance	per capita	1-5 (bins) *
	Climate-related official development assistance	(USD per capita)	1-4 (bins)
	Clean transport (or passenger transport / non-motorised transport) investment	per capita	1-5 (bins) *
	Transport household expenditures	– (GDP per capita)	1-5 (bins) *
6. Governance	Climate targets	–	1-5 (bins) (ordinal ranking)
	Transport climate targets	–	1-5 (bins) (ordinal ranking)

Dimension	Indicator	Denomination (potential alternative approach)	Scoring
	Clean fuels regulatory policy strength	–	0-5 (bins) (ordinal variable)
	Vehicle pollutant emissions standards	– (GDP per capita)	1-4 (bins) (ordinal variable)
7. Energy	Renewable / clean energy overall share	– (GDP per capita)	1-5 (bins) *
	Renewable / clean energy transport share	– (GDP per capita)	1-5 (bins) *
	Carbon intensity of electricity	– (GDP per capita)	0-1
	Biofuels, electricity share in transport	–	1-5 (bins) *
	Road transport fuel (petrol, diesel, electricity) prices	–	1-5 (bins) *
	Crude oil / oil products import dependence	per capita (GDP per capita)	1-5 (bins) *
8. Context	Ambient (outdoor) air pollution (particulate matter 2.5 concentration)	– (GDP per capita)	0-1
	Particulate matter 2.5 concentration attributable to road transport	– (GDP per capita)	0-1
	Particulate matter 2.5 concentration – road transport share of total	–	0-1
	Deaths attributed to road transport air pollution	per capita	0-1
	Road infrastructure (share of paved)	– (GDP per capita)	% (0-1)
	Road safety (deaths)	per capita	0-1
	Awareness / support for climate policies, investments	– (GDP per capita)	1-5 (bins) (ordinal ranking)
	Challenges to sustainable mobility (e.g. landlocked, mountainous, weather)	–	1-5 (bins) (ordinal ranking)

* Indicates "binning" approach where data are grouped and then scores are applied, such as a four-bin method where data are sorted by quartile. The final score is then applied to each bin.

Denomination

For the time being, we have chosen to not denominate many indicators that could be denominated based on GDP or GDP per capita.

There are many indicators that either clearly do not require denomination or else could be denominated by GDP or GDP per capita (both as proxies for level of economic development). These include variables such as percentages (e.g. lending interest rates, modal shares), implicitly normalised variables (e.g. transport household expenditures as a percent of total household expenditures, walkability score) or extensive variables for which normalisation has not yet been performed (e.g. fuel policy regulatory strength, road transport fuel prices, outdoor air pollution concentration levels, etc.).

Insofar as some of these indicators are correlated with a country's level of economic development, some of these could arguably be denominated based on GDP per capita. For instance, ambient air pollutant concentration is the prototypical example of a variable that follows the "environmental Kuznet's curve": low concentrations at low levels of development, higher concentrations in middle-income countries, and low concentrations in advanced economies.

Many of the other indicators are likely to be correlated with economic development, and so an argument could be made for denomination based on GDP per capita (these are shown in Table 3 with normalisation by GDP per capita in parentheses). To keep things simple, we did not denominate according to GDP per capita in most of these cases, for two reasons:

- The correlation between the variable and the level of economic development, as proxied by GDP per capita, is not necessarily monotonic: the Kuznets curve rises to a certain level of GDP per capita, and then falls. So proxying based on GDP per capita would require an analysis of these correlations and communication of these patterns to users of the TDI.

- Even in cases where the general correlation is monotonic (e.g. infrastructure investment), there are likely to be non-linearities in the relationship with GDP per capita that are likely to make it more difficult to clearly communicate and to score the normalised metric. Hence, we have chosen to not denominate by GDP per capita for most indicators.

To make them comparable across countries, other variables clearly require denomination based on total population or the subset of the population living in urban regions. These include extensive monetary values (e.g. fossil fuel subsidies, climate-related official development assistance) or physical quantities (e.g. paved road length). Parameters that reflect transport modes available to only urban residents (e.g. rapid public transport system extent, walkability scores) are denominated based on urban populations. Here again, many indicators are likely to correlate strongly with level of economic development, and an argument could be made to denominate by GDP per capita. For the reasons explained above, we have generally chosen not to do this.

Scoring

Although there are many methods for scoring indicators, each of which has its advantages and disadvantages, as an initial step for the subset of explored indicators, suitable approaches could include: min-max, distance to target, percentile ranking and ordinal (categorical) scales.

The advantage of min-max scoring (simply scaling from the minimum to maximum value found in the data) is its ease of use and ensuring uniform scaling of all characteristics. However, this approach is susceptible to outliers, which leads to a distortion of the normalised values. The problem of outliers, which distort the results, was also discovered during the testing. This applies in particular to the emission indicators, which if scored using min-max normalisation will result in a few countries receiving very high scores and many receiving low scores. This also occurs with the indicators on transit system length.

In some cases, a modified min-max approach may be suitable. Using the public transport example, if a few countries have tens of thousands of system kilometres but most countries have hundreds or less, all of these countries would be pushed to a very low score by the very high ones. In such a case, a logarithmic approach might be best, or setting bins to ensure that each bin contains a similar number of countries – such as assigning countries with over 10,000 kilometres a score of “10”, countries with 5,000-10,000 kilometres a score of “9”, countries with 1,000-5,000 kilometres a score of “8”, and so on, down to where even countries with 50-100 kilometres score a “5”, 10-50 score a “4”, etc.

Other indicators may not be best represented by a linear system at all. An example is motorisation rates, which can be represented by the number of vehicles per 1,000 inhabitants. In this case, very high rates (such as in the United States, Canada and Australia) may not represent the most sustainable (and highest-decarbonisation) levels of ownership. On the other hand, very low levels may suggest poor mobility opportunities for many people. A level that is consistent with an overall sustainable system, such as exists in Europe or Japan, in the range of 400-500 vehicles per 1,000 inhabitants, might be considered the most sustainable. In such a case, an indicator score could rise up to this level, then decline again above this level. Setting the specifics of such a scoring system could be seen as fairly arbitrary.

The currently implemented scoring approach is shown in Table 3 above. The scoring approach for the newly adopted indicators in the updated TDI is based mostly either on min-max methods or on separating values into discrete bins based on the distribution of values. We adopted min-max scoring for continuous variables where the minimum and maximum values could be readily identified, and where the distribution of values was not highly skewed (e.g. as a lognormal or exponential distribution). We adopted bins (mostly either from 0 to 5 or from 1 to 5) based on the minimum, quantiles (including the median, and first and third quantiles), mean and maximum values for each indicator.

The benefits of such an approach are that it is easy to implement (e.g. in Excel) and communicate. The drawbacks are that it arbitrarily reduces the degree of information conveyed by the original data (by turning continuous variables into discrete ones), and that it creates challenges when seeking to combine and weight multiple indicators (e.g. within a given dimension). Specifically, while it is relatively simple to communicate weighting across scaled "min-max" continuous variables (based on bounding the scoring between 0 and 1, and then applying the score), incorporating binned scores into this composite requires that they are also assigned values between 0 and 1, which then are necessarily discrete. Note that this challenge of combining discrete indicators will exist anyways for dimensions that contain inherently ordinal indicators, such as "governance" (which contains only ordinal indicators).

Based on the recognition that the binning approach results in unnecessary loss of information, and on the need to combine and weight scores across multiple indicators, we propose to revisit the scoring methods adopted. Previous experience from one of our team members with the JRC's COINr package (JRC, 2023) will enable us to improve our scoring methods. In particular, we propose to:

1) Verify or modify the use of simple "min-max" scoring, based on closer examination of the distribution of values for each indicator where we scaled scores from 0 to 1 (including for indicators that are percentages).

2) Replace all bins based on continuous variables using Winsorisation and nonlinear transformations (as implemented in COINr), which will ensure that the scoring corrects for skewed distributions in the normalised indicators. These are indicators including an asterisk in the final column ("scoring") in Table 3).

3) Develop a method to combine inherently ordinal indicators with continuous variables that have been scaled from 0 to 1.

Two examples illustrate the potential value of alternatives to the currently adopted denomination and scoring system.

<u>Example 1: Oil import dependence</u>

Oil (crude, product) import dependence is a variable for which we have chosen to adopt more complex methods. This indicator is normalised first on a per capita basis, to derive the net import of oil and oil products in megajoules (MJ) per capita. Scoring is then done based on applying bins. Countries with more than 50 MJ/capita of net imports or exports are designated as "high importers" and "high exporters", respectively. Countries with 10-50 MJ/capita of net imports or exports are designated as "medium importers" and "medium exporters", respectively.

For countries with an absolute net import or export balance of less than 10 MJ/capita, a secondary screen is applied based on a secondary normalisation of net oil (crude and product) imports per unit of GDP (gigajoules per current international dollars in purchasing power parity, PPP). If this secondary screen exceeds 500 (in absolute value), then countries are designated as "medium" importers or exporters, otherwise they are scored as "close to balance", i.e. net imports and exports are similar when scaled according to the country's size (both in terms of population and GDP).

The logic underlying this binning is that very large countries with relatively low values of trade per capita could still be major players in terms of oil trade, if their economies are large. The second layer of checks classifies India as a "medium importer" and Nigeria as a "medium exporter", whereas they both would have otherwise been designated as "close to balance" without the second layer of checks.

Note that the above approach still has the drawback of arbitrarily making continuous data discrete (binning), thereby losing valuable information that could be used to compare within bins. Future work will seek to apply similar logic (based on normalisation both per capita and by GDP), and scoring on a continuous basis (effectively on a combination of population and GDP).

<u>Example 2: Car ownership</u>

The second variable that poses particular challenges to denominate and score is car ownership. This is typically communicated on the basis of vehicles per 1,000 people (effectively a per capita scoring). However, car ownership also generally increases monotonically (at a decreasing rate) with increasing GDP per capita, all else being equal (other highly correlated variables include long-term fuel prices [with an inverse correlation], population density [inverse], availability of and investments in public transport [inverse], and presence of domestic car makers, among others), Hence, while we have currently adopted a simple per capita denomination, in future work we will explore normalisation methods that allow to control for GDP per capita, while ensuring that the final scoring is continuous and ranges from 0 to 1 (making it “min-max”).

Normalisation

Following the scoring of the individual indicators, we add a second level of normalisation of the variables to ensure that they are on a common scale before aggregating them into composite values. During the first pilot phase, we explored several normalisation methods to find a suitable approach for the TDI.

Min-max normalisation scales all variables to a uniform range, typically between 0 and 1, ensuring direct comparability of indicators. It provides consistent scaling across all characteristics, but is susceptible to outliers that can distort the normalised results.

$$IS_i = \frac{V_i - min\,(V)}{(V)\ - min\,(V)} \qquad (1)$$

IS_i: Score of indicator *i* after normalisation

V_i: value of indicator *i*

(V) : max value for the indicator based on Table 3

(V) : min value for the indicator based on Table 3

Z-score normalisation standardises the data based on the mean and standard deviation, making it easier to compare indicators based on their deviation from the mean. The method deals efficiently with outliers.

$$IS_i = \frac{V_i - \mu}{\sigma} \qquad (2)$$

IS_i: Score of indicator *i* after normalisation

V_i: value of indicator *i*

μ: Mean value of the indicator across all observations

σ: standard deviation of the indicator across all observations

Borda count ranks each option based on preference, aggregating scores for all respondents to reflect the overall score.

$$IS_i = \sum_{j=1}^{n} R_j - r_{ij} \qquad (3)$$

IS_i: Score of indicator *i* after normalisation

R_j: Rank of indicator j for observation i

r_{ij}: Actual rank of observation j for indicator i

Scaled normalisation transforms values relative to predefined upper and lower limits and scales them to a specific range (e.g. 0 to 100).

$$IS_i = \left(\frac{V_i - L_i}{U_i - L_i}\right) \times scale\ factor \qquad (4)$$

IS_i: Score of indicator *i* after normalisation

V_i: value of indicator *i*

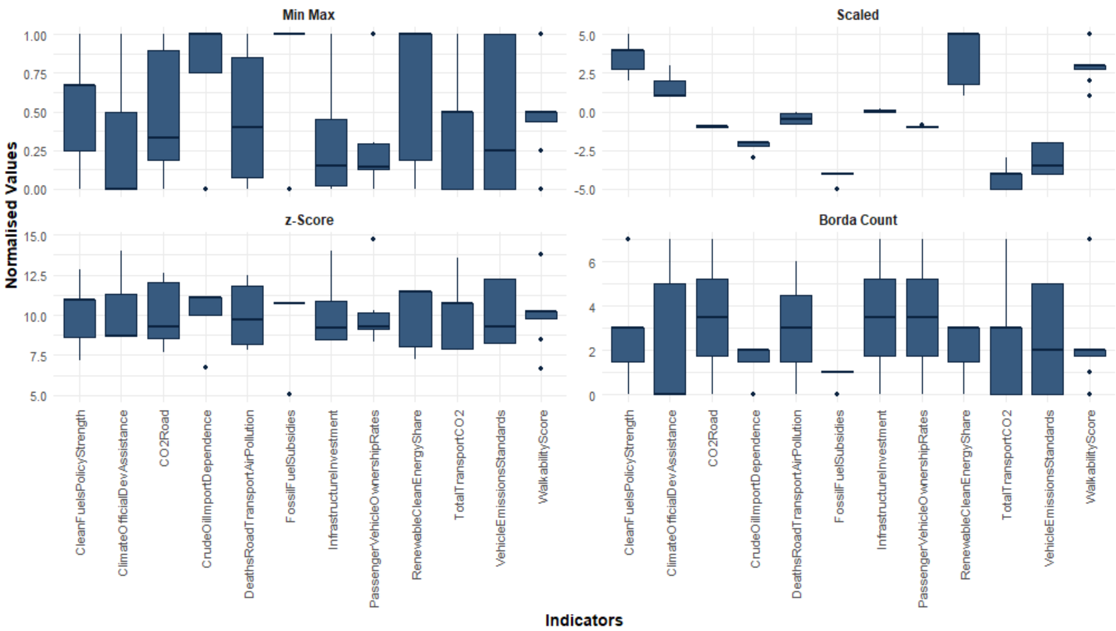
U_i: max value for the indicator based on Table 3

L_i: min value for the indicator based on Table 3

$scale\ factor$: Scale factor to set the range of the normalised indicator

Figure 6 illustrates the impact of the different normalisation methods on the distribution of the indicators. While these boxplots are illustrative and do not represent the final results of our analysis, they visually show how different normalisation methods can adjust the spread, central tendency and range of the data.

Figure 6: Example of normalised indicators across normalisation methods



3.3 Weighting

As described in the State of Knowledge Report, weighting is often considered the most difficult and delicate step in index development, where opinions often differ on the method to be chosen. Weighting can be avoided altogether, although this means that every indicator effectively has the same weight, which is then an implicit weighting system.

A key point is that while a particular weighting system may be chosen for a "base case" in reporting, multiple weighting systems can be shown to indicate how the TDI scores and rankings change, and how sensitive they are to the weighting system. While in some examples below, we show weighting systems being applied to a wide range of indicators, we suggest that any weighting system applied to the TDI indicators in our system be based on the eight dimensions, not to individual indicators. This avoids a situation where one dimension with, for example, five indicators is automatically weighted more heavily than another dimension with only two indicators. Thus in an "unweighted" approach, the eight dimensions are all treated equally. This and other approaches are discussed further below.

Equal weights

$$w_i = \frac{1}{n} \tag{5}$$

w_i: Weight assigned to indicator *i*

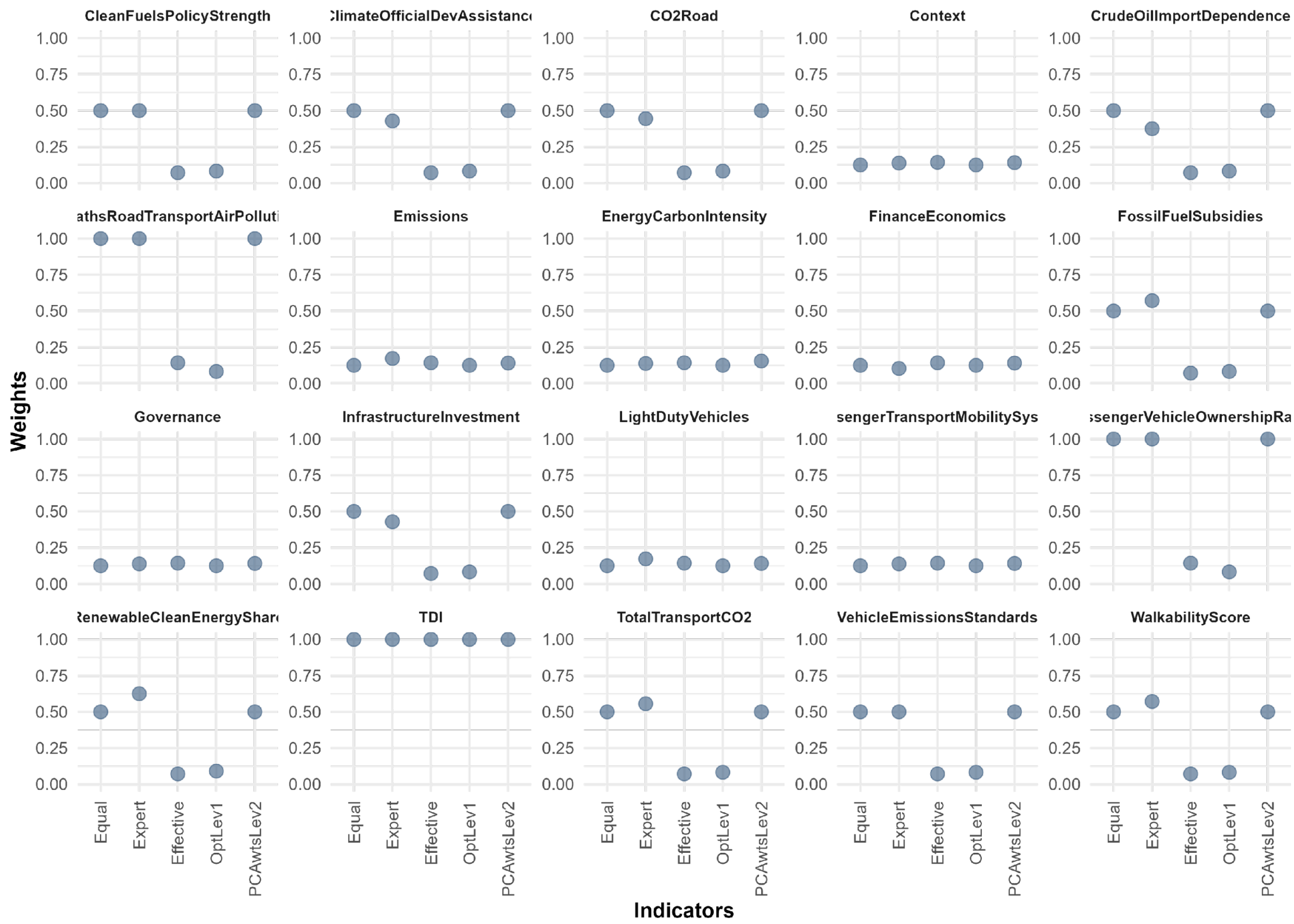
n: total number of indicators (e.g. within one dimension)

Methods such as the Analytic Hierarchy Process (AHP), Data Envelopment Analysis (DEA) or the Delphi method are frequently used and can be a useful way to develop the TDI. Advantages and disadvantages of selected methods that are commonly used in the development of sustainable transport indices, following Illahi et al. (2020), have been outlined in the State of Knowledge Report (Mejia et al. 2024).

To further illustrate this issue, weights were applied to a selected subset of the index components. An explorative weighting was selected based on the discussions and an individual assessment of each respective indicator's importance for transport decarbonisation. Note that the selection of weights can be very subjective and should be treated with caution.

Figure 7 shows an example comparison of the weightings determined and applied for selected indicators and dimensions under different weighting methods during the first pilot phase. The comparison includes equal weighting, opinion/expert weighting, optimised weighting and principal component analysis (PCA) weighting as well as the effective weights.

Figure 7: Example of weights across weighting methods



Expert opinion

$$w_i = \frac{\sum_{j=1}^{m} s_{ij}}{\sum_{i=1}^{n} \sum_{j=1}^{m} s_{ij}} \qquad (6)$$

w_i: Weight assigned to indicator *i*

s_{ij}: Weight assigned to indicator *i* by expert j

m: total number of experts

n: total number of indicators (e.g. within one dimension and each dimension)

The “expert opinion” involves gathering input from experts to determine the weights of indicators. PCA transforms the data by aligning the first principal component with the direction of greatest variance, which can help to simplify the data by reducing its dimensionality. For composite indicators, PCA can help validate the aggregation of indicators, especially when most indicators within a group are well represented by a single principal component, reducing potential information loss. However, the application of PCA-derived weights to composite indicators is complex. While it is attempted to capture as much variance as possible, the weights can lead to an unbalanced weighting scheme that sometimes even assigns negative weights or disproportionately emphasises highly correlated indicators.

During the second pilot phase, additional indicators and countries will be included to expand the TDI. Table 4 presents example weights for equal and expert weights for each TDI indicator and dimension, as described in section 3.1. The final expert-derived weights will depend on the opinions and insights indirectly and directly collected and collated through exchanges with the project advisory group.

Table 4: Example weighting scheme for all indicators

Dimension	Indicator	Equal Weights	Opinion Weights
1. Passenger transport / mobility system	1.a Trip or person kilometres travelled share of passenger transport / non-motorised transport	0.125	0.121
	1.b Public transport (bus, rail) system extent	0.125	0.121
	1.c Percent near frequent public transport	0.125	0.152
	1.d Percentage near protected bikeways	0.125	0.121
	1.e Walkability score	0.125	0.121
	1.f Public transport ridership	0.125	0.152
	1.g Infrastructure investment	0.125	0.091
	1.h Rural transport access	0.125	0.121
2. Light-duty vehicles	2.a Vehicle ownership rates	0.125	0.097
	2.b Vehicle sales size	0.125	0.097
	2.c Vehicle CO_2	0.125	0.161
	2.d Age of fleet	0.125	0.161
	2.e Average age of vehicles sold or imported	0.125	0.129
	2.f Light-duty ZEV sales / stocks, shares	0.125	0.129
	2.g Two/three-wheeler ZEV sales / stocks, shares	0.125	0.097
	2.h Bus ZEV sales / stocks, shares	0.125	0.129
3. Freight system and vehicles	3.a Truck versus rail / water share	0.2	0.150
	3.b Truck emissions ratings	0.2	0.250
	3.c ZEV truck sales / stock share	0.2	0.250
	3.d Truck in-use emissions / tonne-kilometre	0.2	0.200
	3.e Infrastructure investment	0.2	0.150
4. Emission	4.a Total transport CO_2	0.5	0.556
	4.b Transport CO_2 by mode	0.5	0.444
5. Finance and economics	5.a Clean transport (or passenger transport / non-motorised transport) investment	0.2	0.158
	5.b Fossil fuel subsidies	0.2	0.211
	5.c Clean transport fiscal policies / incentives	0.2	0.158
	5.d Availability of low-cost climate finance	0.2	0.316
	5.e Transport (or fossil transport) household expenditures	0.2	0.158
6. Governance	6.a Climate targets	0.25	0.25
	6.b Transport climate targets	0.25	0.25

	6.c Vehicle regulatory policy strength	0.25	0.25
	6.d Clean fuel regulatory policy strength	0.25	0.25
7. Energy	7.a Renewable / clean energy overall share	0.167	0.192
	7.b Renewable / clean energy share in transport	0.167	0.167
	7.c Carbon intensity of electricity system	0.167	0.192
	7.d Carbon intensity of liquid fuel system (or biofuels or non-fossil share)	0.167	0.154
	7.e Road transport fuel prices / taxes	0.167	0.154
	7.f Crude oil / oil products import dependence	0.167	0.115
8. Context	8.a Awareness / support for climate policies, investments	0.25	0.15
	8.b Road infrastructure (paved / unpaved)	0.25	0.15
	8.c Road safety (deaths)	0.25	0.25
	8.d Specific country challenges to sustainable mobility (pollution, landlocked, mountainous, weather)	0.25	0.45

ZEV = zero-emission vehicle

3.4 Aggregation

In the final step, the treated, denominated, normalised and weighted indicators are aggregated into a final index. As the analysis of existing indicators has shown, the way in which the indicators are aggregated can vary across the different levels of the index and the indicators. The aggregation will be conducted within the dimensions using simple linear aggregation. In this approach, the results are presented as cumulative scores, with each higher-level score being the sum of its weighted lower-level components. Specifically, the TDI score is calculated from the sum of the weighted dimension scores, and the dimension scores are derived from the sum of the normalised and weighted indicator scores for the indicators in each respective dimension.

The indicator value is aggregated for each dimension:

$$DS_j = \sum_{\forall i \in j} W_i \times IS_i \qquad (7)$$

DS_j: Dimension score *j*

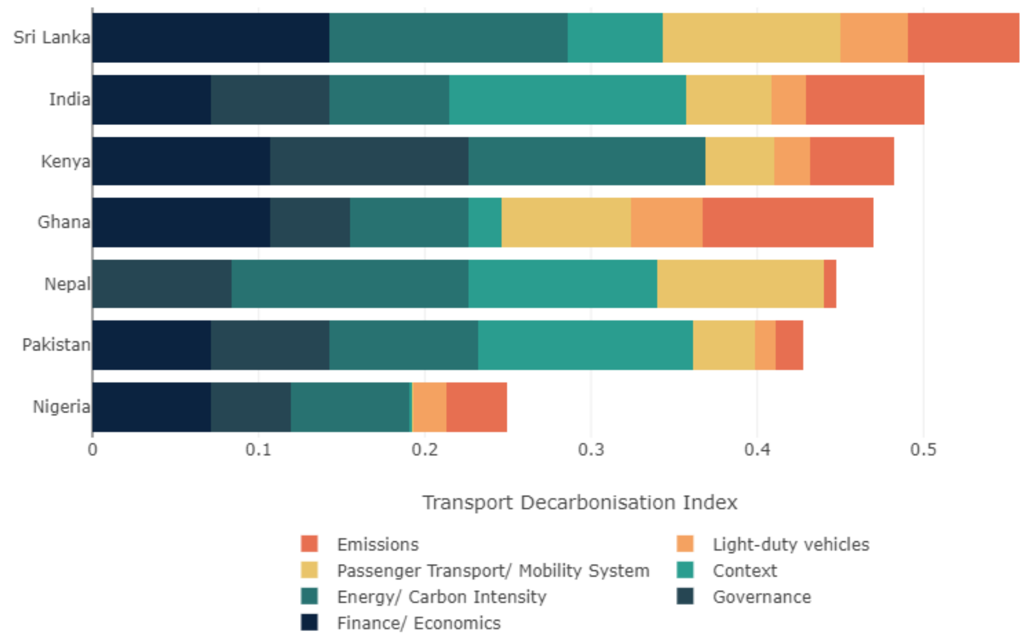
W_i: Weight of the dimension to which the indicator *i* belongs

IS_i: Score of indicator *i* in the dimension *j*

Thus, the aggregation indicates scores from 0 to 100 for the dimensions. A score of “100” is seen as the best performance possible for a country, while a score of “0” would indicate severe issues and challenges. The scores are classified in several classes (e.g. 90 to 100, 80 to 90) to be able to contextualise the score and provide an explanation of what this outcome means (see next section).

Figure 8 shows the aggregated TDI using min-max normalisation and weighted arithmetic aggregation. The figure is segmented into seven of the nine dimensions and provides a preview of the visualisation of the final TDI results. Although this is not representative of the actual results, it serves as an illustrative example.

Figure 8: Example of the aggregated TDI across its dimensions



3.5 Policy guidance

The TDI scoring results are linked to illustrative, non-prescriptive advice on policy actions. The idea is to provide informed policy decisions in order to ensure value for policy makers. The policy guidance outlines how a country can improve and decarbonise its transport system. The recommendations depend on the scores – that is, a list of policy actions will be connected to the identified low scores. Policy actions are shown for the two lowest-scoring dimensions. For example, if governance and emissions have the lowest score among the dimensions, then illustrative policy actions are shown for these two dimensions.

The number of potential policy actions on sustainable transport is infinite. To limit the scope, actions that are perceived to have a significant emission reduction impact are being included. The actions are sourced from the latest knowledge products on sustainable, low carbon transport (IPCC, 2022; SLOCAT 2022, 2023). It is also linked to previous HVT projects on 'Quick Wins' for low-carbon transport, which identified ten policy interventions considered to be most relevant for low-income countries (SLOCAT 2019).

This is essentially a mapping exercise, applying the following criteria:

- The policy options should be distinguished and clear.
- They are structured following the dimensions of the indicator assessment.
- They are associated with the indicators by addressing the same topics.

The following options are illustrative, non-prescriptive activities that will need to be operationalised with more detail and specific measures and involving the relevant stakeholders. The policy guidance should be taken with caution and assessed against the country context and its needs. Recent research by Stechemesser et al. (2024) shows that, especially in transport, the highest emission reductions can be achieved through a combination of several policies.

The main dimensions of the indicator assessment are applied to structure the policy actions, which are:

1. Passenger transport and mobility system

2. Light-duty vehicles

3. Freight system and vehicles

4. Emissions

5. Finance and economics

6. Governance

7. Energy

8. Context

All illustrative, non-prescriptive policy actions are sourced from recent recognised, well-established knowledge and advocacy products with a focus on sustainable, low carbon transport. For every dimension, between 8 and 10 policy actions have been identified and included in the assessment.

1. Passenger transport and mobility systems

The policy options in this first category focus on improving public transport infrastructure and systems, walking, cycling and rural transport.

- Shift to public transport (through infrastructure expansion, new services and fare programmes, service improvements, prioritisation)
- Cycling improvements (infrastructure, policies, parking, financial incentives)
- Walking improvements (infrastructure, policies, financial incentives)
- Prioritisation of collective transport, walking and cycling in investments, planning and infrastructure
- Rural transport development by providing access to all-weather roads
- Integrate informal transport in public transport
- Road tolls and parking fees for private vehicles on major roads and specific areas
- Transit-oriented development and land use improvements (mixed use and compact city approaches)
- Supporting policy frameworks (e.g., National Urban Mobility Plans, Sustainable Urban Mobility Plans in primary and secondary cities)

2. Light-duty vehicles

This category focuses on options that reduce the carbon intensity of light-duty vehicles. The activities can support the transition to zero-emission vehicles.

- Light-duty vehicle taxes (based on pollution, size, usage)
- Light-duty vehicle import regulations (including bans; especially)
- Electric charging infrastructure (focusing on cars, buses, two/three-wheelers)
- Electric vehicle procurement (focusing on cars, buses, two/three-wheelers)
- Electric vehicle import levies (focusing on cars, buses, two/three-wheelers)
- Sharing of electric vehicles (focusing on two/three-wheelers and cars)
- Domestic production of electric vehicles
- Encouragement of the gradual replacement of the fleet with newer vehicles

3. Freight system and vehicles

The category aims to improve freight transport services and promote improvements through regulations and policies.

- Medium- and heavy-duty vehicle taxes (based on pollution, size, usage)

- Medium- and heavy-duty vehicle import regulations (including bans)
- Medium- and heavy-duty vehicle air pollution emission standards
- Electric charging infrastructure for medium- and heavy-duty vehicles
- Electric vehicle procurement (focusing on freight vehicles)
- Electric vehicle import levies (focusing on freight vehicles)
- Domestic production of electric vehicles
- Shifting freight movement to more sustainable modes (rail, shipping)
- Reduce empty load running by trucks, route optimisation, asset sharing

4. Emissions

This category aims at tackling transport emissions directly. The suggested policies are based on decarbonisation pathways.

- Carbon tax and pricing mechanism
- Emission trading scheme covering transport
- Integrated approach, such as the Avoid-Shift-Improve framework for sustainable transport
- Zero-emission zones in urban areas
- Car-related travel pricing mechanisms (congestion, road charging, workplace parking levy etc.)

5. Finance and economics

Financial and economic policy actions target transport policies as well as overarching investment frameworks. The actions are collected from recent knowledge and advocacy products on this topic (TUMI et al., 2022).

- Prioritise sustainable transport in planning and investment frameworks
- Investments in sustainable transport
- Removal of inefficient fossil fuel subsidies
- Shifting finance from polluting modes towards zero-emission vehicles
- Introduce policies and incentives to support clean transport
- Enabling private financing to the transport sector
- Provision of financial support on transport for low-income households (e.g., transport subsidies, mobility passes, purchase subsidies)

6. Governance

This section aims to strengthen governance-related aspects. The focus is on climate strategies (Nationally Determined Contributions (NDCs) and Long-Term Low Emission Development Strategies (LT-LEDS)), vehicle regulations and fuel regulations.

- Transport greenhouse gas mitigation targets in NDCs and LT-LEDS, ideally aligned to the low-carbon transport pathways of the Intergovernmental Panel on Climate Change
- Transport actions in NDCs and LT-LEDS, both on mitigation and adaptation in a comprehensive manner across Avoid-Shift-Improve
- Alignment of targets in NDCs, LT-LEDS and national strategies

- Phase out the sales of vehicles with internal combustion engines by a certain year
- Taxes to incentivise (advanced) biofuels and clean energy sources
- Vehicle emission regulatory policies (such as Euro III to VI)
- CO_2 performance standards for new light- and heavy-duty vehicles (Euro VII+)
- Clean fuel regulatory policies

7. Energy

The policy actions on energy look at areas that indirectly influence decarbonisation of the transport sector by pointing to cleaner energy systems.

- Advanced biofuels
- Renewable energy-sourced electricity for transport
- Renewable energy increases in power mix
- Carbon pricing to encourage the use of green/clean energy
- Energy efficiency mandate
- Fossil fuel tax
- Fuel quality standards to reduce air pollutants, such as black carbon and other short-lived climate pollutants

8. Context

The category on context grasps additional aspects that are relevant to sustainability in transport for a country. Thus, the policies look directly at improving these identified sustainability aspects.

- Road safety improvements focusing on safety of people walking, cycling, using motorcycles and using public transport
- Speed limits on roads
- Connectivity improvements to other countries (e.g. international, cross-border rail linkages)
- Campaigns to promote usage of public transport, walking and cycling as well as electric mobility
- Campaigns for ecodriving and more awareness about climate impacts of travel choices
- Road transport network development with climate-proof design standards
- Peer exchange and capacity building with countries facing similar challenges

4 Application

4.1 Spreadsheet toolkit

This section outlines the spreadsheet toolkit for the TDI and indicates how a user will apply the TDI for a country assessment. The spreadsheet toolkit is a key element in the project because any policy makers or practitioners that want to apply the TDI will do so via the toolkit. Thus, the toolkit needs to be self-explanatory, easily accessible and simple enough to use even with little technical knowledge on transport. The toolkit combines the indicator assessment and policy guidance and automates the process to the best extent possible. It means that after a user has provided all relevant information, the user will be able to view the scores and a list of relevant policy actions.

Background

The TDI is supported by a spreadsheet toolkit that enables users to conduct a self-assessment of a country's transport system. This diagnostic toolkit aims to indicate through the assessment the status and readiness of a country towards transport decarbonisation. It ensures the TDI's overall objectives of supporting evidence-based, time-sensitive and targeted decisions on emissions reduction towards surface transport decarbonisation in LMICs in Sub-Saharan Africa and South Asia.

Toolkit objectives

The TDI project is rooted in a comprehensive approach that encompasses an array of surface transport modes, including road, rail, and inland waterways, addressing both passenger and freight transport. The project aims to provide a diagnostic toolkit to evaluate current states, identify barriers and gaps, and outline the required ambition towards a decarbonisation pathway. This is crucial for LMICs in the targeted regions, where the intersection of transport with broader socio-economic factors, such as accessibility, affordability, and urban development, adds layers of complexity to the decarbonisation challenge.

The spreadsheet in the framework of the TDI has the following objectives:

- To assist LMICs to apply the TDI to their surface transport systems;
- To allow a country to understand its preparedness and readiness towards achieving net zero greenhouse gas emissions by 2050 in the transport sector;
- To provide a score that might enable comparison with other countries and tracking of long-term progress by multiple applications of the TDI over the years.

Approach

The toolkit will take the form of an Excel file because this is perceived to be the most accessible platform for practitioners and policy makers in LMICs. The toolkit will be accessible on the HVT website, together with a user guide and all other relevant deliverables of the project. The spreadsheet toolkit can be downloaded and used as a local file. Once downloaded, it will not require an internet connection. The Excel spreadsheet toolkit is not resource-heavy and should run on most computers. Users can input transport data on a specific sheet (see below) and will be provided with a score for the overall composite index and scores for the subdimensions. Explanations about what the score means are provided alongside the results.

Features

The spreadsheet toolkit will have several features that should help a user navigate through the toolkit, understand the project and apply the TDI. These features ensure that the user can quickly and easily grasp the idea of the TDI and apply the toolkit. All of this information is presented in a clear and concise manner, with weblinks if there is a need for further details.

The key features of the TDI spreadsheet toolkit are:

- **Project overview:** A description of the TDI project and involved partners, including a table of contents with direct links to every sheet.

- **Indicator description:** A sheet outlining all indicators and how they are structured within the components and subdimensions of the index. The metrics and units for each indicator are shown.
- **Data resource list:** An overview of potential third-party data sources that can be used for the TDI.
- **Automated scoring:** Embedded calculations and formulas to produce the scoring; once a user inputs the data, the toolkit automatically outputs all scores.
- **Weighting adjustments:** The ability for users to select their own weighting (see discussion below).
- **Visualisations:** Figures and charts based on the TDI results.

User instructions

This sheet provides a step-by-step guide on how to use the spreadsheet toolkit. It is a six-step process for a user towards the successful application of the toolkit.

Step 1: Read through *Overview* and *1.a - Toolkit introduction* to get familiar with the TDI project and the purpose of the spreadsheet toolkit.

Step 2: Look carefully through *1.c - Indicator description*, especially if you plan to adjust indicator weights (see step 5).

Step 3: Prepare the data for your country. For any major gaps, please consult *1.d - Data resources list* for third-party data sources.

Step 4: Input the data into *3 - Inputs sheet*. To ensure the correctness of the TDI, please make sure to use the same units as indicated in *1.c - Indicator description* and *3 - Inputs*. Fill out data for as many indicators as possible. A larger amount of data will ensure more robust scores.

Step 5: (Optional) If you wish to adjust the weights to reflect specific priorities or the country context, you can adjust the weight of each indicator in the column “Adjusted weight” and tick the associated box in *3 - Inputs*.

Step 6: Check the results in *2 - TDI composite score*. Results are available for both the overall score and the subdimensions scores. Read carefully through the explanations.

Weighting adjustments

The default weighting system of the TDI is equal weighting. As mentioned above, a feature of the TDI toolkit is that the user can adjust the indicator weights. This might be valuable in the case that a user wants to prioritise certain aspects or that they want to reflect a specific national context in the TDI assessment. For example, if a country wants to focus on rail development, the user from the country might want to apply higher weights for rail-focused indicators.

However, weighting adjustments should be conducted with caution because:

- Misinterpretation and different indicator scores might happen. The results and scoring are adjusted to a specific range linked to the weighting set by the project team.
- Changing weights limits the comparability with TDI scores from other country assessments. The calculations for the scores will be affected by the weighting adjustments, so the final score is not anymore based on the same approach as other available TDI assessments.

  These warnings are featured in the toolkit, making the user aware of the implications of adjusting indicator and dimension weights.

Structure

The spreadsheet is organised according to the following structure:

- Overview
- 1.a - Toolkit introduction
- 1.b - User instructions
- 1.c - Indicator description
- 1.d - Data resource list
- 2 - TDI composite score
- 3 - Input

The first sheet is the “Overview” sheet that users will see first when they access the toolkit (see Figure 9).

The details of each sheet are described below:

- **Overview:** Includes the table of contents and descriptions of the organisations involved. This sheet provides the version number of the toolkit, a brief description of the TDI project and information about the partners. It also includes hyperlinks to partners’ websites and to the HVT TDI website to access further information.
- **1.a - Toolkit introduction:** Contains a detailed presentation of the TDI project, including context, approach and methodology, selected scope of the TDI and relevant information. Hyperlinks to TDI-related reports (State of Knowledge Report, Data Source Report, TDI Methodology Report, user guide) are also captured on this sheet.
- **1.b - User instructions:** Contains a step-by-step guide on how to use the spreadsheet toolkit, with details on how it is to be applied. (See “User instructions” section above.)
- **1.c - Indicator description:** Provides a detailed description of every indicator that constitutes the TDI. For each indicator, this sheet contains information about metrics and relevance, with the aim of providing the user with an accurate description of how the indicator was built.
- **1.d - Data resource list:** Provides a list of potential public data sources (ATO, EDGAR, World Bank, etc.) that could be used for inputting country data to the TDI. For each data source, a brief description of what type of data can be found is included.
- **2 - TDI composite score:** Contains the results of the TDI calculation, with the score for each of the subdimensions. This sheet includes explanations on how to interpret the results and draft relevant conclusions. Visualisations for better understanding or trend analysis are also available here.
- **3 - Input:** Contains fields necessary for the TDI score calculation. Users can fill out these fields with their data. Users are also able to adjust the weight of different indicators, in order to focus on specific impacts or dimensions and to account for specificities of the studied country. This is the only sheet that users will need to edit.

Figure 9: Cover of spreadsheet toolkit

OVERVIEW

Worksheet	Worksheet description
1.a - Toolkit introduction	Detailed presentation of the project, including context, approach and methodology, selected scope of the study and other information.
1.b - User instructions	List of instructions in order for the user to make the best use of the toolkit.
1.c - Indicator description	Detailed list of every indicator that constitutes the TDI. For each of the indicators, this sheet contains information about metrics and relevance of indicators. It has the objective to provide the user an accurate description of how the indicator was built.
1.d - Data resource list	A list of potential data sources easily and freely available, that could be used for implementing the TDI in the spreadsheet toolkit.
2- TDI Composite Score	Contains the results of the TDI calculation, with the score for each subdimensions. It also include explanations about how to interpret the results and draft relevant conclusions.
3- Input	Contains all data necessary for the TDI score calculation. This is the only sheet that users will be able to edit.

Version: 1.0, released in October 2024

About the TDI

SLOCAT and the **Urban Electric Mobility Initiative (UEMI)** are collaborating on the development of the **Transport Decarbonisation Index (TDI)** to assess progress and barriers, enabling evidence-based decisions on emissions reduction in surface transport for low- and middle-income countries (LMICs) in Sub-Saharan Africa and South Asia. The TDI is instrumental for policymakers in developing targeted emission reduction actions and supporting LMICs in fulfilling their climate pledges, with an ultimate goal of achieving net zero by 2050 to limit global warming to 1.5 degrees. Beyond diagnosing decarbonisation efforts, the TDI also serves as a progress tracker, indicating whether more stringent measures may be necessary in the future.

SLOCAT

SLOCAT is the international, multi-stakeholder partnership powering systemic transformations and a just transition towards equitable, healthy, green and resilient transport and mobility systems for the people and the planet. We deliver on our mission through co-creation, co-leadership and co-delivery across knowledge, advocacy and dialogue activities in the intersection between transport, climate change and sustainability. Our multi-sectoral Partnership engages a vibrant and inclusive ecosystem across transport associations, NGOs, academia, governments, multilateral organisations, philanthropy and business; as well as a large community of world-class experts and change-makers. Going where others do not or cannot go individually, our Partnership is leveraged to set ambitious global agendas and catalyse progressive thinking and solutions for the urgent transformation of transport and mobility systems worldwide.

SLOCAT Partnership on Sustainable, Low Carbon Transport

Contact us: https://slocat.net/contact/

UEMI

The Urban Electric Mobility Initiative (UEMI) is a global movement driving the transition to cleaner, more livable cities through electric transportation solutions. Launched by UN-Habitat in 2014, UEMI brings together industry leaders, governments, and cities to achieve a shared vision:
30% electric vehicles in cities by 2030.
With commitments from industry and government, UEMI functions as an open forum for knowledge transfer and support for the take-up of e-mobility solutions around the world. It initiates a process of dialogue and continue to gather commitments from local and national governments as well as businesses on e-mobility targets. The Action Platform has been established with a work programme setting out voluntary international, national and city targets on e-mobility such as the global market share of electric vehicles and total number of passenger kilometres travelled on e-vehicles. While these targets will be voluntary in nature, a global monitoring system will be developed to track progress on implementation.

UEMI www.uemi.net

Contact us: https://www.uemi.net/

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More about this projet: https://transport-links.com/funded-projects/transport-decarbonisation-index-tdi

HIGH VOLUME TRANSPORT APPLIED RESEARCH

4.2 Overcoming data gaps

Data gaps in the TDI development process can arise for various reasons, including lack of data availability, insufficient data coverage, outdated data and lack of data granularity. Identifying these gaps early in the development of the index is crucial for implementing effective solutions. As outlined in the State of Knowledge Report, the preliminary analysis of potential data sources highlights the variable availability of transport-related data across different regions and countries. For example, the Asian Transport Outlook (ATO) database provides a wealth of data for Asian countries, but similar comprehensive databases are lacking for African regions.

Strategies for overcoming data gaps

Despite efforts to prioritise indicators with broad coverage across all countries, national policymakers (or other users of the Surface Transport Decarbonisation Index) may find that certain indicators are missing for their country. In such cases, for tracking progress within a given dimension or comparing the situation with other countries, the simplest and most straightforward approach is to treat the indicator as missing. However, if there is a need to estimate the value of an indicator without available data, it is possible to use proxies.

The first step is to identify countries for which data on the indicator are available, and to consider as proxies those that are most similar along the dimension(s) most relevant to that indicator. For example, when selecting data related to infrastructure, safety, or LDV characteristics, it would make sense to select countries with a similar level of economic development (as indicated by GDP per capita), geographic proximity, or those from which second-hand vehicles are imported. Ultimately, the choice of proxy country or countries will depend on individual judgment. The use of proxy data should be limited, and any caveats related to the derived score should be clearly stated.

One of the aims of relying primarily on international, harmonised data is to make national authorities and policymakers aware of indicators that are missing in their country, and to encourage efforts to address these gaps.

1. **Alternative data sources and proxy indicators:** In cases where direct data are unavailable, alternative data sources and proxy indicators can be employed. This means that a country might use data from another country with similar characteristics for its assessment.

2. **Data imputation techniques:** Once an indicator has been included in the index, missing data can be dealt with in various ways, and a decision must be made as to whether the data should be imputed and which method should be used. Statistical methods can estimate missing data points. Techniques such as mean imputation, regression imputation and multiple imputation offer ways to handle missing data, allowing for constructing a more complete dataset.

3. **Collaboration and data sharing:** Engaging with local governments, non-governmental organisations, academic institutions and international organisations can facilitate access to unpublished or localised data. Collaborative efforts can also lead to the establishment of new data collection initiatives, particularly in regions where data is scarce.

4. **Leveraging technology and citizen science:** Advances in technology, such as remote sensing, mobile data collection, and crowdsourcing, can help fill data gaps. Citizen science projects can also be instrumental in collecting data on variables such as mobility patterns, public transport use and non-motorised transport.

5. **Capacity building and technical assistance:** Supporting LMICs in developing their data collection and management capabilities is a long-term solution to data gaps. Training, technical assistance, and funding for national statistical offices and transport ministries can improve data quality and availability over time.

6. **Adaptive and iterative methodology:** The TDI development process should be flexible, allowing for iterative updates as new data become available. This adaptive approach ensures that the index remains relevant and accurate over time.

To support these strategies, foremost this methodology report details all needed data points. It is designed to allow any user with technical expertise on transport to understand the capacity needs, the data required and potential alternative proxy data. Furthermore, the project has produced a Data Source Report with an overview of data sources and data sets for each of the featured indicators. This will allow users to make use of global data sources and any other sources that might be unknown to them.

Case studies and examples

- **Asian Transport Outlook (ATO):** The use of the ATO database for South Asia demonstrates how regional databases can contribute greatly to overcoming data gaps. Efforts to develop a similar comprehensive database for the African region could be instrumental in addressing data challenges.

- **Sustainable Cities Index:** Launched in 2021, the Sustainable Cities Index evaluates global cities on air quality, emissions, renewable energy, transport and mobility access, and other sustainability measures through an interactive, crowd-sourced approach. Initially featuring 50 cities using public data, the index expanded in 2023 to include 70 cities, with an aim to grow further as more cities contribute their data. The State of Knowledge Report includes an overview of 56 potential data sources at the national, regional and local levels. As part of the mapping of existing indices, a list of around 200 potential indicators has been identified.

Among the collected potential data sources, the ATO database emerged as an important source for the Asia-Pacific region, providing transport-related data from 51 countries in Asia and the Pacific, including all South Asian countries. This database is methodically organised into nine different sections: Infrastructure, Transport Activity and Services, Access and Connectivity, Road Safety, Air Pollution and Health, Climate Change, Socio-Economic Factors, Transport Policy, and Other Indicators, covering a total of 486 indicators. It provides a comprehensive overview of data availability by cataloguing various official and secondary data sources and making them accessible openly.

Utilising the ATO database as a first step provides a pragmatic approach to data collection for the TDI, particularly for South Asia. This database provides a structured framework that not only helps collect the required data but also serves as a model for structuring similar data collection frameworks in African countries. It is anticipated that efforts similar to the ATO will be useful for the African region, where data availability is difficult. In the medium term, this approach could inspire the creation of a similar database for the African region.

While the ATO comprehensively collects information from reliable and validated sources such as the Emissions Database for Global Atmospheric Research (EDGAR), the International Energy Agency, and the World Bank, some additional indicators should be collected, such as those related to the country context or the share of renewable energy. Data from other sources and existing indices, such as the World Bank's Logistics Performance Index and the World Economic Forum's Global Competitiveness Index, were also included in the first set of potential indicators. However, when integrating these indices into the TDI, care must be taken to maintain the transparency and reliability of the overall index results.

The selected indicators aim to capture certain aspects of different index dimensions and subdimensions. Among others, it uses data on current and historic CO_2 emissions from roads, rail and waterways (including international shipping) from the JRC (2023) database and financial indicators from the IMF (2024).

5 Conclusion

The TDI supports low- and middle-income countries to decarbonise surface transport via a toolkit that diagnoses the state of decarbonisation and identifies pathways to achieve net zero greenhouse gas emissions by 2050. The TDI attempts to go beyond the decarbonisation of surface transport by linking to wider benefits such as accessibility and affordability of mobility. To this end, the TDI captures the status of surface transport decarbonisation, actions and readiness.

This report outlines the complete methodological framework for the TDI. It outlines the structure of the TDI, the indicators, normalisation, weighting and aggregation approaches. All calculation methods for every level of the TDI (indicators, dimensions and overall composite score) are shared. The spreadsheet toolkit that accompanies the TDI is outlined, and its features are presented.

The TDI methodology report is a product of several consultations and research on transport decarbonisation assessments. The piloting of draft indicators helped to refine the indicators and better understand what data can be covered. The consultations throughout the project pointed to how the TDI needs to be communicated and what features are necessary to make it a valuable tool.

This methodology report provides a comprehensive explanation and context for end users. The full methodology provides a step-by-step guide to assist interested stakeholders in collecting and benchmarking the TDI for a country, with clear instructions on how to proceed, including a final list of indicators, ways to overcome data gaps, and methods and tools for calculating the index.

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